High-Power Transmitter High-Voltage Power Supply Ripple

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This article reports the results of decreasing the high-voltage power supply ripple by redesigning the low-pass filter.

I. Introduction

During a routine checkout of the high-power transmitter at DSS 14 located at Goldstone, California, it was noticed that the digital fast klystron body detector, a body overcurrent sensing device, continuously tripped the transmitter high-voltage off. Investigation showed that the ripple voltage of the high-voltage power supply had increased sufficiently to cause the body peak currents to activate the fast body detector.

II. Investigation

Measurements were made of the ripple voltage at the output of the dc filter (Fig. 1). It was found that the ripple voltage was very high, approximately 300 volts; the high-voltage specification is .1 percent of the high voltage. This high ripple voltage indicated further problems in the filter choke (inductor) or capacitor. The capacitor was checked and found to be in good condition. The inductor was then checked and found to have changed its inductance from 1 henry to .1 henry. It was theorized that the gap in the iron of the inductor had changed resulting in a change in inductance. However, the high-voltage insulation isolating the inductor coil from the iron core had not broken down. It was tested to 80 kV with a high-potential tester. The spare inductor was installed and the ripple voltages checked again including the inductor input and output. It was found that the input ripple was alarmingly high. The three phase full wave output of the transformer-rectifier should be 4.2 percent instead of the 75 percent found. This indicated strongly that the filter system was resonating. DSS 63 and DSS 43 were then checked and they were found to be operating in the same condition; the ripple voltage was 30,000 volts while running the klystron at 35,000 volts. The filter in its old configuration was a choke (inductor) input filter. It was then changed to a pi configuration. Tests were run to determine the optimum value of the input capacitor to be used and .2μF was the determined value.

III. Conclusion

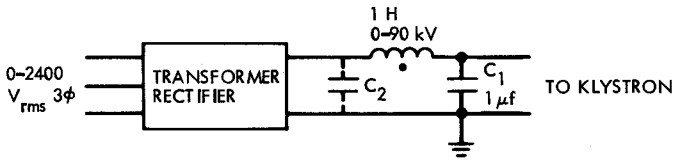
A temporary Engineering Change Order was written in order to change the filter to a pi configuration using a .15μF capacitor on the input that was immediately

available. In the future this will be changed to the .2μF capacitor. Results of the new filter are shown in the enclosed photos. Figure 2a shows the ripple voltage without any capacity at the input to the filter which is 15,000 volts (original configuration). The dc voltage is 20,000 volts. Figure 2b shows the input of the filter at 20 kV dc with a .15μF capacitor at the input pi configuration. As can be seen, the ripple voltage is reduced to less than 1,000 volts peak-to-peak.

Figure 3a shows the ripple voltage at the output of the filter (choke input). The ripple voltage is greater than 50 volts peak-to-peak at 20 kV dc. Figure 3b shows the ripple voltage at the output of the new filter, pi configuration. As can be seen, the ripple is reduced to less than 20 volts peak-to-peak.

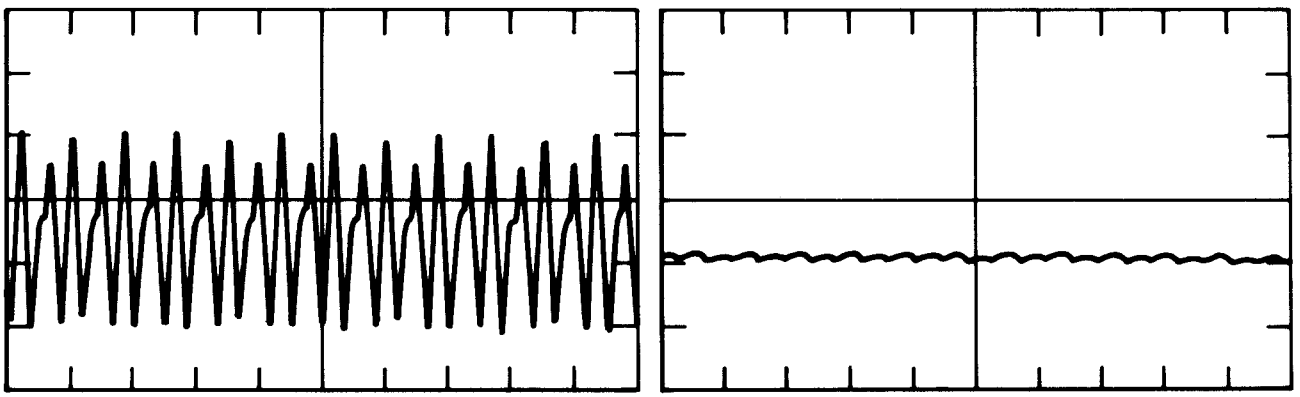
Figure 4 shows the ripple at the klystron operating level of 60 kV. The ripple at this point is approximately 30 volts peak-to-peak. The input ripple to the filter was 3,800 volts; this is within specs for the filter and the output ripple is within specs for the transmitter.

This will reduce the modulation on the klystron output in the future, thus transmitting a purer spectrum.



C_2 ADDED TO MAKE A π FILTER

Fig. 1. High-voltage power supply and filter configuration



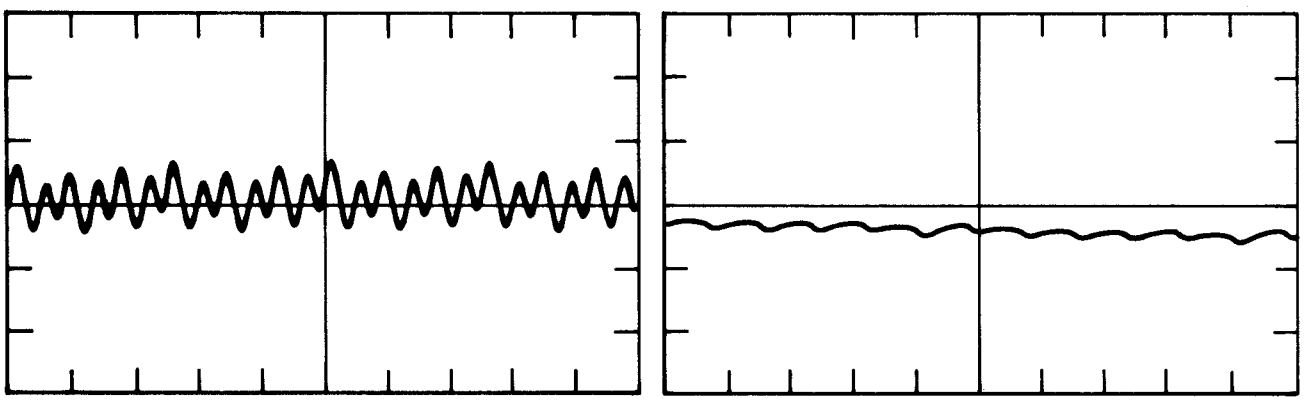
'A' NO CAPACITY

VERT = 5000 V/cm
V_{dc} = 20 kV
HOR = 1 ms/cm

'B'

0.15 μf CAPACITOR ON INPUT

Fig. 2. High-voltage power supply ripple (input)



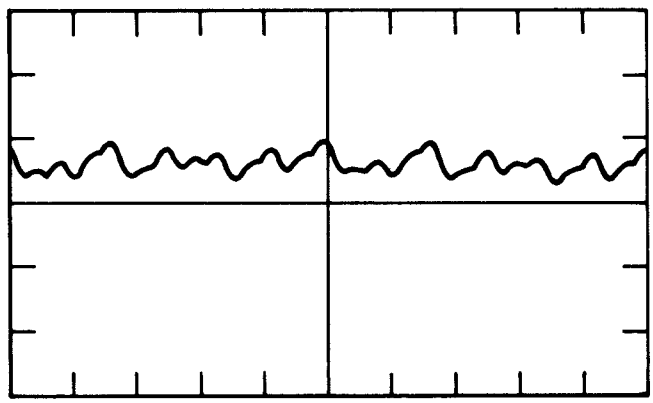
'A' NO CAPACITOR

VERT = 50 V/cm
V_{dc} = 20 kV
HOR = 1 ms/cm

'B'

0.15 μf CAPACITOR ON INPUT

Fig. 3. High-voltage power supply ripple (output)



V_{dc} = 60 kV
VERT = 50 V/cm
HOR = 0.5 ms/cm

Fig. 4. High-voltage power supply ripple, output of filter